GENERAL OUTLOOK

As the result of a more general recognition of the basic importance of mineralogy in pure and applied science and in various branches of industry, and with a national society boasting of a membership including the progressive investigators and devotees of the subject, and with a well established and widely recognized official monthly publication, the future of mineralogy in America is assured. The problems of really fundamental significance requiring a comprehensive knowledge of crystallography and mineralogy are indeed many. The applications of the methods and truths of our science are constantly increasing and if America is to assume leadership in this great field it can be most speedily and advantageously accomplished through the friendly cooperation of the members of an organization such as this.

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SEX IN THE TREMATODE FAMILY SCHISTOSOMIDÆ[1]

THE trematode family Schistosomidæ in addition to containing three species which produce important human diseases, viz., *Schistosoma hæmatobium, S. mansoni,* and *S. japonicum,* is interesting because it is the only group of the trematodes in which the sexes are separate in the adult stage, which lives in the vertebrate. In this stage there is an extreme sexual dimorphism, the structure of the male being adapted for grasping the female in the gynæcophoric canal during copulation and the female having a very long slender body. The complete life cycles of the three human species of this family have been worked out in the last seven years, making it now possible to attack the problems related to the determination of sex and the development of sexual dimorphism.

Just what is involved in these problems can perhaps be made clear by a brief outline of the life cycle of one of the human species of this family, *Schistosoma japonicum.* The adult of this species lives in the bloodvessels of the liver and mesenteries of man and other mammals in the far East. The adults are almost always found in copulation in the vessels of the hepatic portal system. The fertilized ovum develops into the miracidium within the egg shell before the egg escapes from the host. The miracidium hatches almost immediately when the egg is voided into the water and dies within a short time unless it comes in contact with a small species of snail, *Blanfordia nosophora* (Robson). It penetrates vigorously into this snail and metamorphoses into a sac-like structure known as the mother sporocyst. The germ cells of the miracidium are carried over directly into the mother sporocyst and develop by parthenogenesis into daughter sporocysts. A single mother sporocyst may live for a considerable period of time and produce several hundred daughter sporocysts. These daughter sporocysts also carry germ cells and produce by parthenogenesis cercariæ which are the larvæ of the diœcious vertebrate-dwelling adults. These cercariæ escape into the water and will penetrate directly through the skin of any suitable host with which they come in contact. From the skin they make their way to the blood vessels of the liver, where they develop to sexual maturity in about three to four weeks. In fact I have seen copulation in an experimentally infested mouse nineteen days after exposure to these cercariæ.

The first question which naturally arises in connection with the sex phenomena in this life cycle is how far back can the sexual dimorphism be traced in the development of the adult from the cercaria in the final host. In a recent series of studies on the development of *Schistosoma japonicum* in experimentally infested mice I have been able to distinguish males from females in specimens about 0.3 mm. in length. Since the body of the cercaria of this species is about 0.15 mm. to 0.20 mm. in length and the smallest sexually mature forms have a length of about

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4 mm. to 5 mm. it can be seen that the sexual dimorphism can be noted at a very early stage. Even in the smaller stages the males have a distinctly larger oral sucker than the females and the body is wider. Also early in development the females show a larger space between the intestinal ceca in front of their point of union than do the males. As development proceeds the differences in size between the suckers of the sexes becomes more distinct. The males become broad and flat and finally the sides of the post-acetabular region curl up to form the gynæcophoric canal. In the females the body tends to become round in cross section and the width is constantly much less than that of males of the same age. A detailed description of this development will be made in a future publication. Fujinami and Nakamura[2] in a paper published in Japanese antedate my findings on early sex dimorphism in *Schistosoma japonicum*. They were able to distinguish the sexes in specimens 0.5 mm. to 0.7 mm. in length, which developed in dogs. They laid especial emphasis on differences in the width of the body and in the character of the intestinal ceca as characters for distinguishing sex.

The next question which arises in this connection is whether sexual dimorphism is present in schistosome cercariæ. Although many workers have made studies and measurements of the cercariæ of the human schistosomes no one has reported such differences. I have myself examined a number of cercariæ of *S. japonicum* with this point especially in mind without noting any dimorphism. Dr. S. Yokogawa, of the Medical College of Formosa, also informs me that he has made an extensive series of examinations and measurements of this cercaria in an attempt to find sexual differences without success. Since the cercariæ of the human schistosomes are very small and can extend and contract their bodies to an unusual extent, slight size differences might escape notice in the living specimens and be difficult if not impossible to detect in measurements of preserved material.

Recently in some studies on a species of schistosome cercaria with eyespots from *Planorbis trivolvis* from Douglas Lake, Michigan, I have been able to demonstrate two distinct size types. This difference in size came to my attention first when I found that the curve plotted from the measurements of cercariæ from a number of infected snails was distinctly bimodal. More extensive studies showed that the cercariæ of this species fell into two distinct size groups. I further found from measurements of the cercariæ from eleven infested snails that in the cercariæ coming from a single snail only one of the size types was represented. The difference in size was so great between these two types that it could be recognized with the naked eye when free-swimming cercariæ of the two types were placed in separate bottles. Measurements of the length of the body of the larger type showed a range of variation from 0.234 mm. to 0.28 mm. while in the smaller type the range was from 0.207 mm. to 0.24 mm. Other measurements of the body and tail, which in this species is unusually large, showed like differences. The adult into which this cercaria develops is not known, although unsuccessful attempts were made to introduce it into ducks and rats. An analysis of its structure, however, places it near to the human schistosomes in the family Schistosomidæ. This relationship means that in all probability in the adult stage of this species the sexes are separate. I therefore interpret the size differences in this species of cercaria as a sexual dimorphism. If this view is accepted the fact that in one infested snail only one of the types of cercaria is represented immediately becomes very significant. A more detailed account of the dimorphism of this species of cercaria will be published later in connection with a study of its structure and activities.

In this connection must be cited the work of Tanabe,[3] on *Schistosoma japonicum*.

[2] Fujinami, A., and Nakamura, H., 1911, "A demonstration of some specimens showing the development of *Schistosoma japonicum*" (Japanese). *Bio ri Gaku Kaishi*, Vol. 1.

[3] Tanabe, K., 1919, "A contribution to the

This author found that in twenty-six out of thirty-one cases when the cercariæ from a single snail were used in infesting experimental animals all the individuals developed were of the same sex. Dr. S. Yokogawa has given me permission to use in this connection the results of some of his experiments along this line, which were performed several years ago. He found that when a cat, dog, or rabbit was infested with the cercariæ from a single snail that worms of only one sex would develop. He also found that in these cases the worms would not develop to maturity. These two workers have developed independently the same hypothesis to explain the results of these experiments.

According to this hypothesis sex in the schistosomes is determined in the fertilized egg and all the cercariæ coming from a single miracidium are of the same sex. When all the individuals derived from the cercariæ from a single snail were of the same sex it would follow that the infestation in this snail was from a single miracidium or two or more miracidia of the same sex. In those cases where both sexes came from the same snail, this snail must have been originally infested with two or more miracidia representing both sexes. Now my findings recorded above in regard to dimorphism in a species of schistosome cercaria, and the presence in one snail of only one of these types, lends further support to this hypothesis. Further, since in the life cycle of *S. japonicum,* the miracidium and the mother sporocyst are the only stages derived from a fertilized egg, it is in these stages that sex differentiation would theoretically be expected. Up to the present time, however, no one has examined these stages to determine whether they show a sexual dimorphism. My purpose in discussing the data given above and the hypothesis derived from them in this preliminary way is to call the attention of zoologists interested in the problems of sex to the interesting condition found in this trematode family.

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knowledge of the morphology and development of *Schistosoma japonicum*'' (Japanese). An abstract of a paper given before the Japanese Pathological Society. *Igaku Chuo-Zashi,* Vol. 17, No. 6.

ORIGIN OF POTATO RUST[1]

A year ago the writer called attention to the threatened introduction into the United States of two more crop pests, the potato rust, *Puccinia Pittieriana,* and the peanut rust, *Puccinia Arachidis.*[2] Since then the latter fungus has been found in one field in Florida, where all vestige of it was at once destroyed. The other fungus has not yet appeared in the United States.

During 1918 the potato rust was very abundant and harmful in the experiment station grounds at Ambato, Ecuador, not only upon potatoes but even more so on tomatoes. This was the first report of the rust in South America, having previously been known only from the high lands of Costa Rica on the potato alone. In Ecuador it showed decided preference for North American varieties of the tomato. An excellent illustrated account of the rust and its behavior, with conjectures on its origin, was published in the bulletin of the Ambato station for January, 1920, by the station botanist, Abelardo Pachano.[3] I take the liberty to quote a few disconnected sentences from this article, after changing them from the Spanish into an English garb.

The rust of the tomato and potato is a wholly new disease, not only in our fields [in Ecuador], but also elsewhere. Not simply the fact of its novelty should interest us, but more particularly its virulence, its ease of propagation, and the enormous injuries that it occasions; these considerations would seem to place it among the most serious maladies of cultivated crops.

The history of this rust [in this region] may be easily sketched. The year 1918 is demonstrated as the date of its first appearance. In fact in the spring of that year we had occasion to observe very grave disturbances, by our horticulturists given the general name of plague, in the tomato plots from seed of North American origin. The varieties most attacked were those by the names Acme, Golden Queen and Black-eyed State. Nearly at the same time we noted similar lesions

[1] Presented to the Mycological Section of the Botanical Society of America at the Chicago meeting, December 29, 1920.

[2] Science, 51: 246–247, March 5, 1920.

[3] *Boletin de Agricultura Quinta Normal,* 1: 7–12, Figs. 1, 2, January, 1920.